ACADEMY OF HEALTH SCIENCES
DEPARTMENT OF MEDICAL SCIENCES
PHYSICAL THERAPY BRANCH

M MTN9-DIB
1101

Central Nervous System: The Brain

References:

Barr ML & Kiernan JA: The Human Nervous System. 5th ed. Philadelphia: J.B. Lippincott Co., 1988.

Goldberg S: Clinical Neuroanatomy made Ridiculously Simple. Miami: MedMaster, Inc., 1990.

Landau BR: Essential Human Anatomy and Physiology. 2nd ed. Glenview, Illinois: Scott, Foresman & Co., 1980

Tortora GJ & Anagnostakos NP: Principles of Anatomy and Physiology. 9th ed. New York: Harper and Row, 2000.

Objectives:

I. Terminal Learning Objective:

Given a list, select the functions, locations and anatomical landmarks of the brain IAW the cited references.

II. Enabling Learning Objectives:

a. State the function, location and names of the three meninges of the brain IAW the above authors.

b. Given general statements about the blood supply, cerebrospinal fluid and ventricles of the brain, select those statements that are correct IAW the above authors.

c. Given a diagram of the cerebral cortex, label the four lobes and the important fissures, gyri and sulci of the cortex IAW the above authors.

d. From a list of statements, select the correct statements that describe the functions of the four lobes of the cerebral cortex, the corpus callosum, basal ganglia and the internal capsule IAW the above authors.

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*This mimeo supersedes M 27 ZEMI-D1B, 1194.

e. From a list of statements, select the correct statements describing the location and

functions of the thalamus, hypothalamus, midbrain, pons, medulla oblongata and cerebellum IAW the above authors.

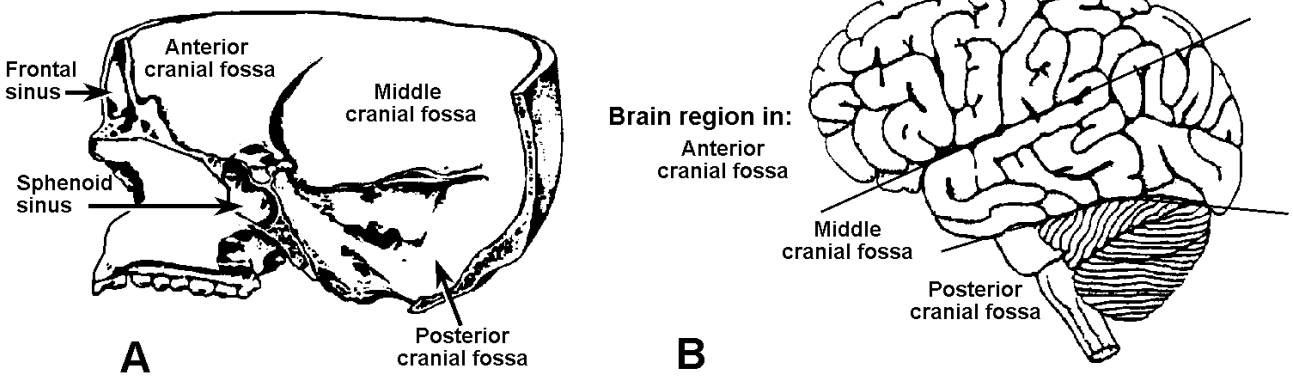
f. On a diagram of the brain, label and select the correct function of the cerebrum, corpus callosum, thalamus, hypothalamus, midbrain, pons, medulla oblongata and cerebellum IAW the above authors.

g. Given a list of clinical disorders, select the correct location of the brain mostly responsible for that disorder IAW the above authors.

NOTES

A. General Information:

1. The brain is composed of four principle parts and a support system. The four principle parts are the **cerebrum**, **diencephalon**, **brainstem** and **cerebellum**. The support system consists of the **meninges**, **cerebrospinal fluid** and **blood** supply.



2. Protective coverings of the brain:

a. The brain is protected from the environment by three barriers: **Skull**, **meninges** and **cerebrospinal fluid**.

b. Skull:

1) The cranium contains the brain. It is composed of eight bones which fuse together after birth.

2) The spaces between the unfused cranial bones in early infancy are **fontanels**. They have a fibrous membrane or cartilage covering which is

later replaced by bone.

c. Meninges:

1) Three protective membranes that act as a barrier against infection.

a) **Pia mater**

(1) The innermost covering.

(2) A thin delicate membrane attached to the brain.

b) **Arachnoid**

(1) The middle covering.

(2) Composed of a covering which lies directly under the dura mater with web-like extensions that attach to the pia mater. The space between the arachnoid and pia mater where the extensions are found is filled with **cerebrospinal fluid**.

c) **Dura mater**

(1) The outermost covering.

(2) A thick, durable membrane attached to the skull.

1) The cranial meninges are continuous with the spinal cord meninges.

2) Clinical aspects - **meningitis**. An infection of the meninges (cranial &/or spinal), usually the arachnoid or pia mater.

d. Cerebrospinal fluid (CSF)

1) Nourishes, removes waste and protects the brain against chemical or physical injury.

2) Flows through the subarachnoid space around the brain and spinal cord, and through the ventricles (spaces) in the brain.

3) CSF is formed by the **choroid plexuses** in the ventricles and by the cellular

lining of subarachnoid space. It is a clear fluid containing glucose, proteins, minerals and other substances.

4) The CSF is reabsorbed into the veins within the meninges and replaced by newly formed CSF.

5) Clinical aspect - **Hydrocephalus**. A blockage within the ventricles of the brain which results in the CSF accumulating within the ventricles that eventually separates the unfused cranial bones and enlarges the head.

3. **Ventricles**:

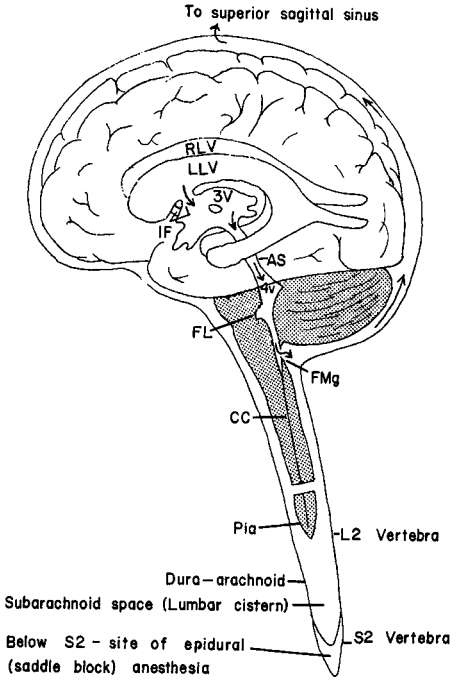
a. There are four ventricles (cavities) within the brain.

1) Two **lateral ventricles**

2) One **third ventricle**

3) One **forth ventricle**

b. The ventricles contain CSF and the choroid plexuses that form the CSF.



4. Blood supply:

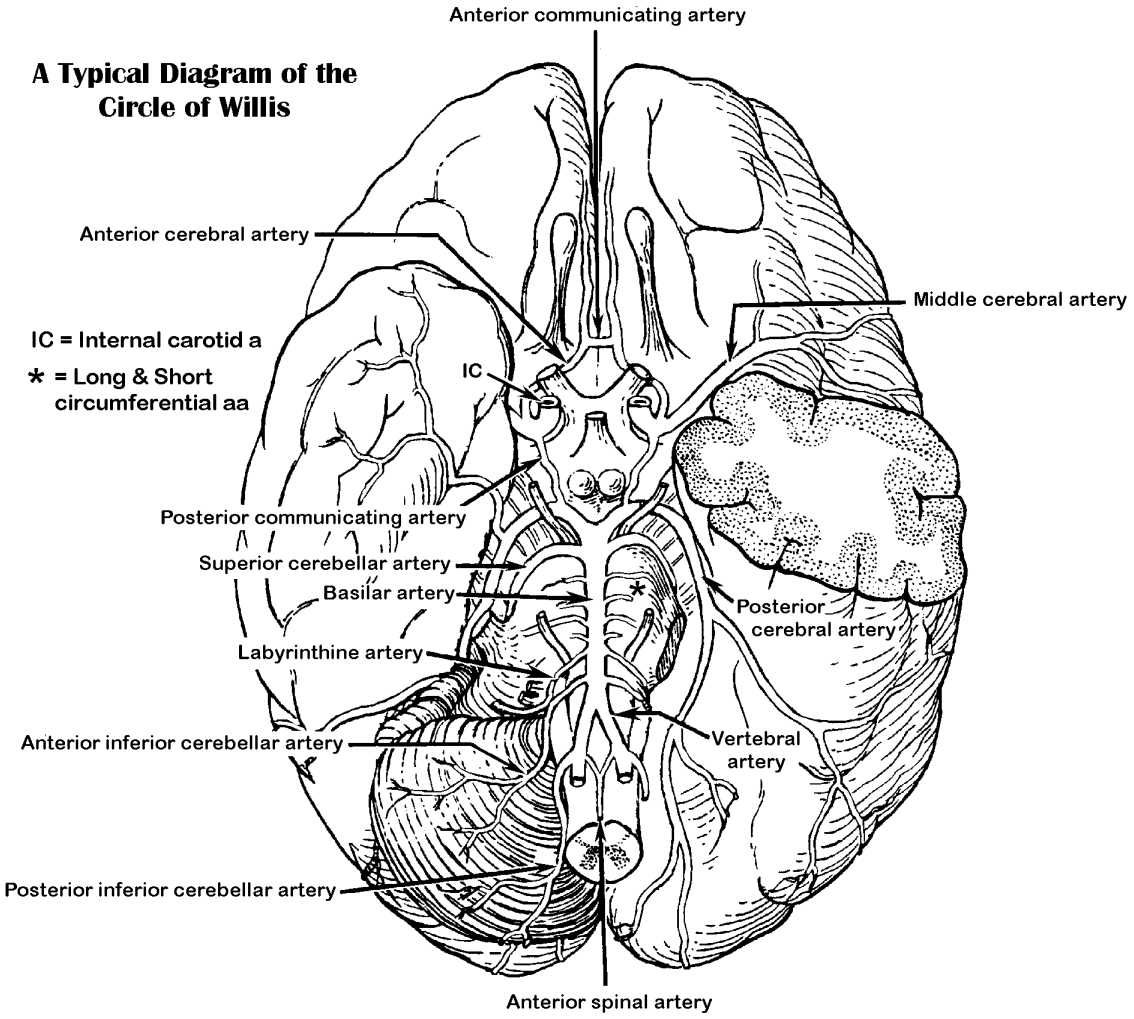
a. Arterial supply:

1) Four major arteries supply the brain.

a) Two **vertebral arteries**

b) Two **internal carotid arteries**

2) The four main arteries interconnect to assure that even if one of the major arteries is unable to supply blood to the brain the other three arteries can distribute blood to the entire brain - The Circle of Willis.



b. Venous supply:

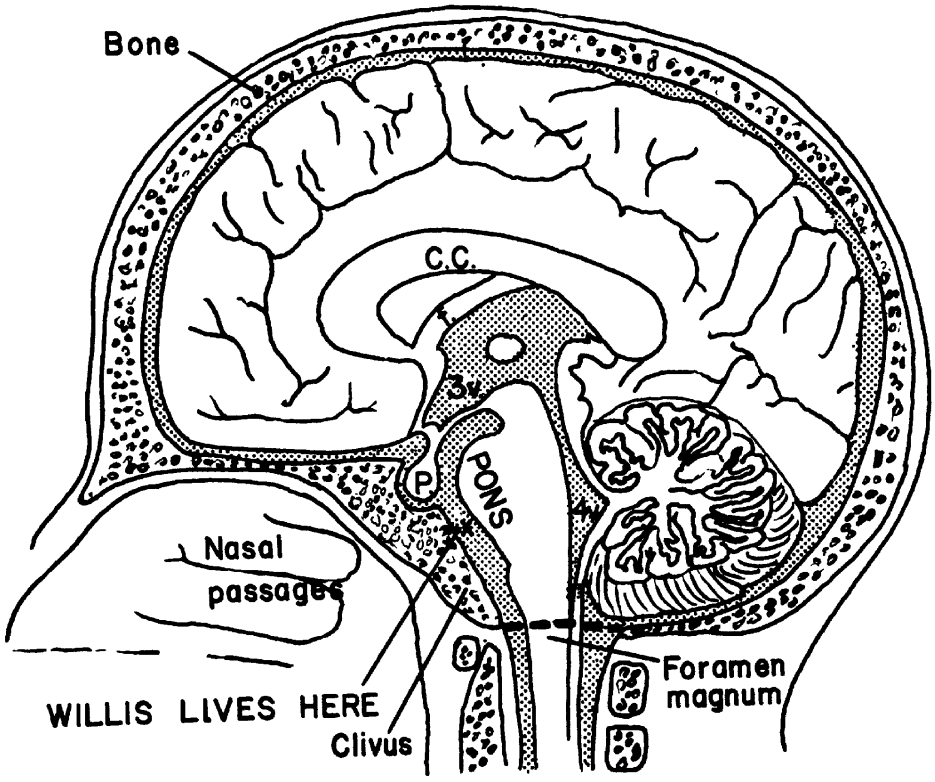
1) A series of veins return the blood to the heart. The main vein exiting the cranium is the internal jugular vein.

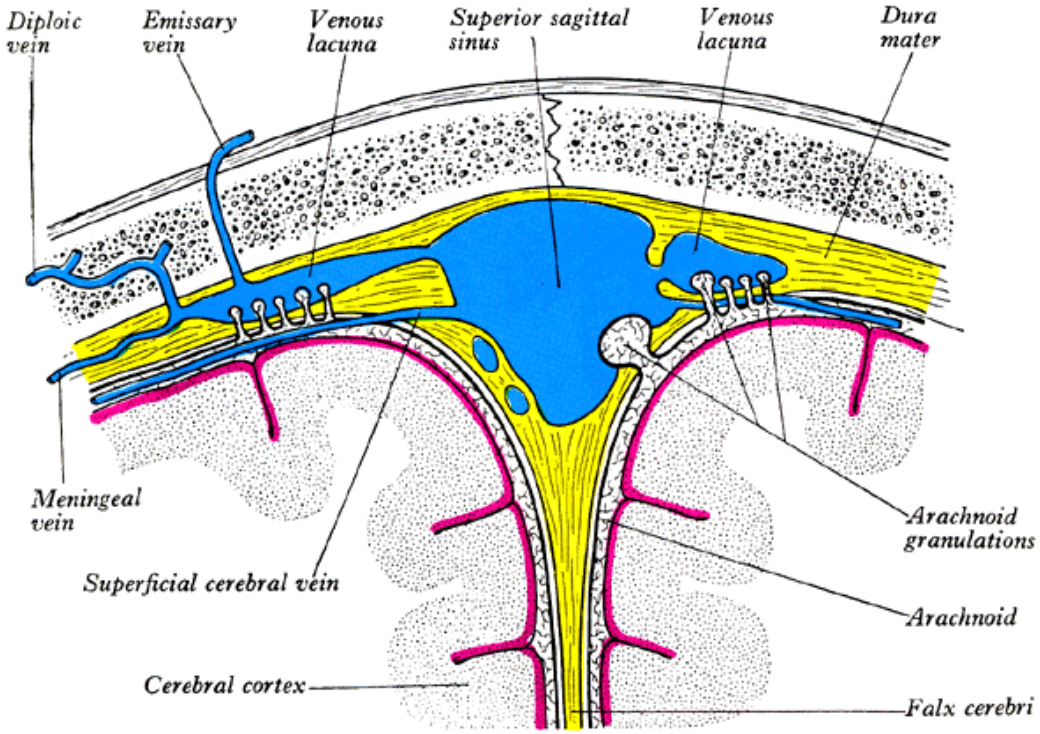
2) Within the brain there are several wide & flat veins called sinuses.

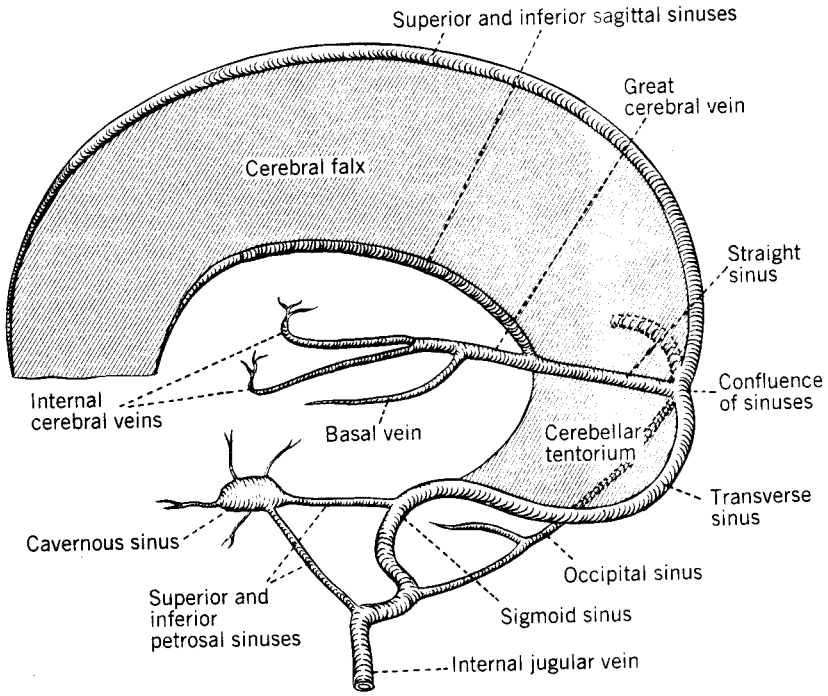
c. Clinical aspect - **Cerebral vascular accident** (CVA)

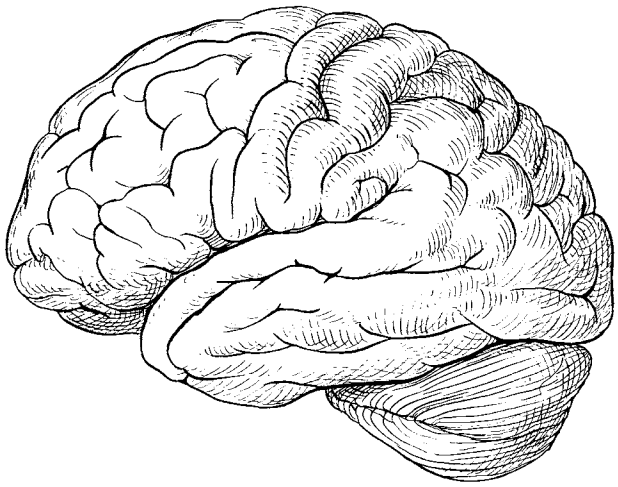
1) Disrupted blood flow to part of the brain causing neurons to die.

2) Wide variety of impairments - aphasia, motor loss, sensation loss, personality changes, etc.




Diploic vein
Emissary vein
Venous lacuna
Superior sagittal sinus
Venous lacuna
Dura mater
Meningeal vein
Superficial cerebral vein
Arachnoid granulations
Arachnoid
Cerebral cortex
Falx cerebri


Superior and inferior sagittal sinuses
Great cerebral vein
Cerebral falx
Straight sinus
Confluence of sinuses
Internal cerebral veins
Basal vein
Cerebellar tentorium
Transverse sinus
Cavernous sinus
Occipital sinus
Superior and inferior petrosal sinuses
Sigmoid sinus
Internal jugular vein



B. **Cerebrum**

1. Location: superior aspect of the brain.

2. **Cerebral cortex** - surface of the cerebrum that is composed of gray matter.

NOTE: Gray matter is nervous tissue that has a grayish color because its contents are not myelinated. White matter is myelinated. Therefore gray matter is cell bodies, dendrites and/or non-myelinated axons.

a. Contains billions of cell bodies, dendrites and axon terminals.

b. Surface structures:

1) **Gyrus** (plural = gyri) - ridges between the sulci.

2) **Sulcus** (plural = sulci) - shallow indentations or grooves between the gyri.

3) **Fissure** - deep grooves

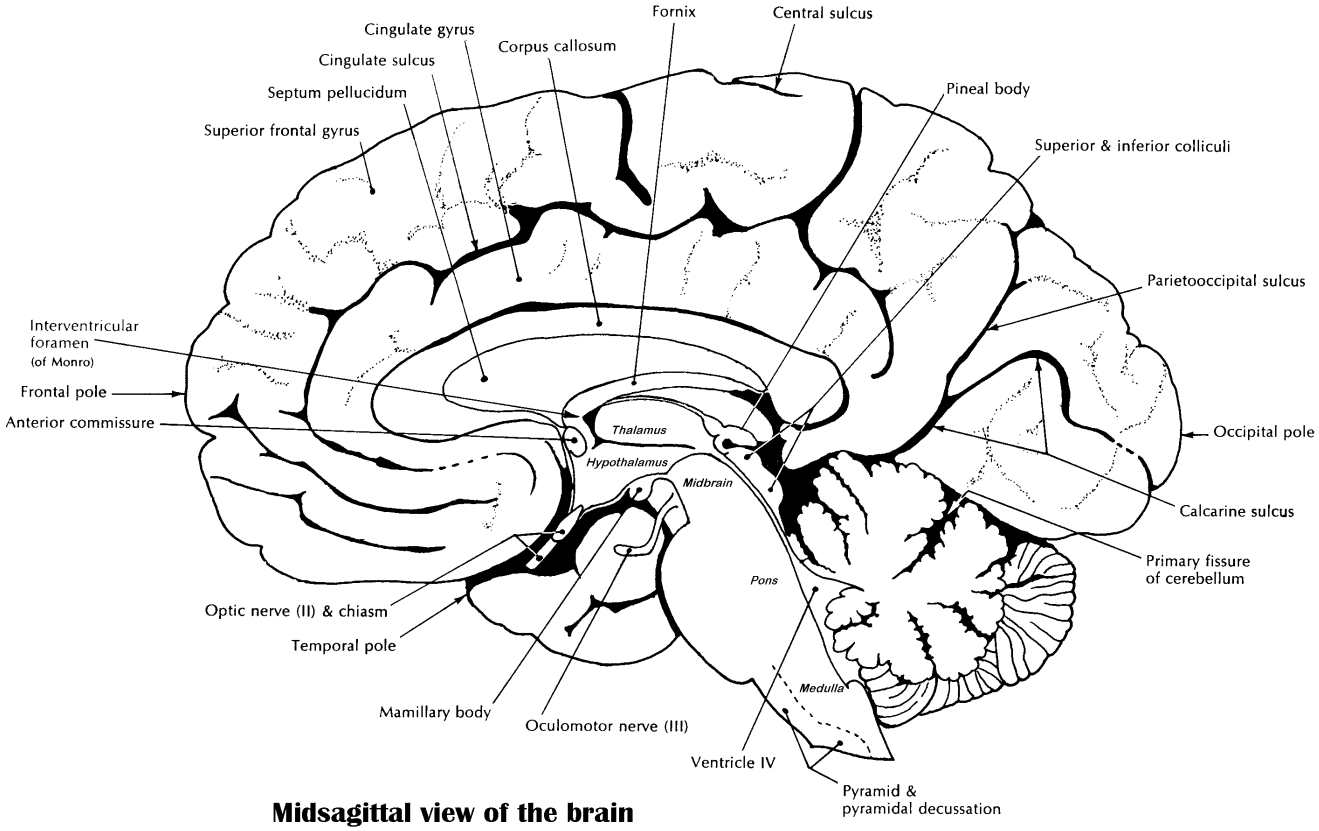
c. Important fissures and sulci:

1) **Longitudinal fissure**: separates the right and left cerebral hemispheres.

2) **Lateral sulcus**: separates the temporal lobe and the parietal lobe of the cerebrum. Runs along the lateral sides of the left and right hemisphere.

3) **Central sulcus**: separates the frontal lobe and the parietal lobe of the cerebrum. Runs laterally down both hemispheres.

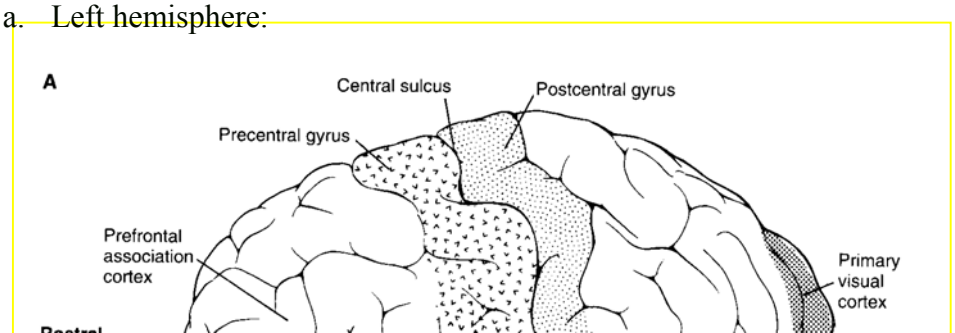
3. Beneath the cerebral cortex lies the **white matter** (myelinated axons) that carry the information to and from the cortex. Deep to the white matter are several areas of gray matter called the **basal ganglia**. This will be discussed later.



Midsagittal view of the brain

4. The cerebrum is divided into two hemispheres.

a. Left hemisphere:



1) Linear thinking
2) Analytical thinking
3) Logical thinking
4) Abstract symbols of language and numbers
5) Speech
6) Reading & writing

b. Right hemisphere:

1) Synthetic thinking
2) Holistic thinking
3) Generating mental images
4) Perception of music
5) Artistic ability & creativity

6) Emotions

5. Lobes of the cerebrum:

a. **Frontal lobe**:

1) Location: anterior to the central sulcus

2) Functions:

a) Initiates voluntary somatic movements on the opposite side of the body.

(1) **Precentral gyrus** - the gyrus immediately anterior to the central sulcus is the primary motor area. The gyrus is arranged in a specific pattern, a homoculus, with each area of the gyrus responsible for a specific area of the body.

(2) **Premotor area** - anterior to the precentral gyrus and controls skilled or learned movements such as writing.

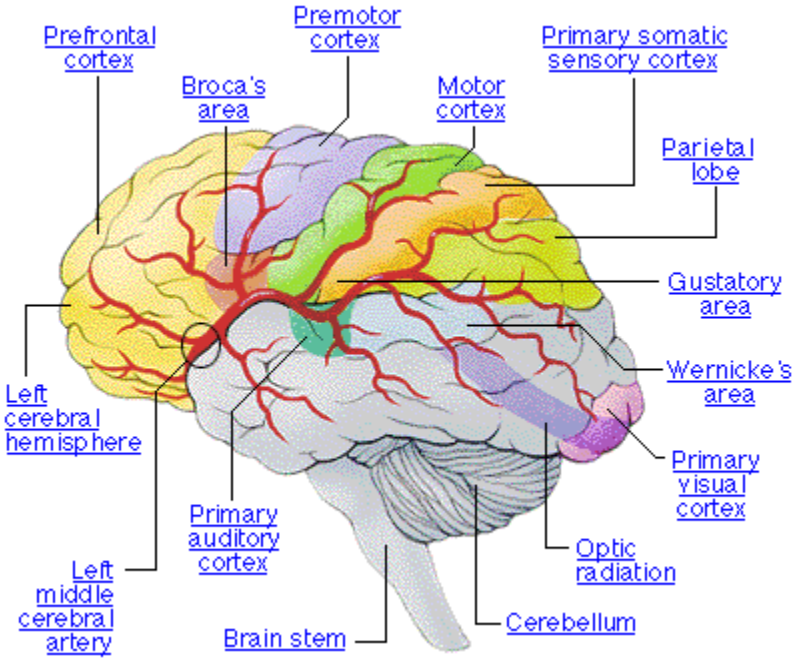
(3) Clinical aspect - Upper motor neuron lesions. (UMN) Lesion of the motor areas of the frontal lobe result in motor deficits on the contralateral side of the body.

b) Personality - frontal pole (most anterior region)

c) Speech production - translating thoughts into words. **Broca's** area (posterior to frontal pole and adjacent to the lateral fissure)

(1) Usually located on the left hemisphere with song production located on the right. (80% of persons)

(2) Clinical aspect - **expressive aphasia** (motor). Unable to get thoughts into words.



b. **Parietal lobe**:

1) Location posterior to the central sulcus and superior to the lateral fissure.

2) Functions:

a) Somatic sensory perception

(1) **Postcentral gyrus** - the gyrus immediately posterior to the central sulcus is the primary sensory area. The gyrus is arranged in a specific pattern, a homoculus, with each area of the gyrus responsible for a specific area of the body.

(2) Other regions of the parietal lobe integrate the sensory perception.

(3) Clinical aspect - lesion of the parietal lobe result in sensory impairment on the contralateral side of the body.

b) **Angular gyrus** - responsible for recognition of written words. Clinical aspect – visual aphasia

c. **Temporal lobe:**

1) Location: inferior to the lateral fissure.

2) Functions:

a) **Auditory** perception - interpretation of rhythm, pitch and sound. (superior region of lobe)

b) Recognition of speech - responsible for translating words spoken into thoughts.

(1) **Wernicke's** area - region anterior and posterior to the auditory region.

(2) Clinical aspect - **receptive aphasia**. Unable to translate speech into thoughts.

d. **Occipital lobe:**

1) Location: posterior region of the cerebrum

2) Function:

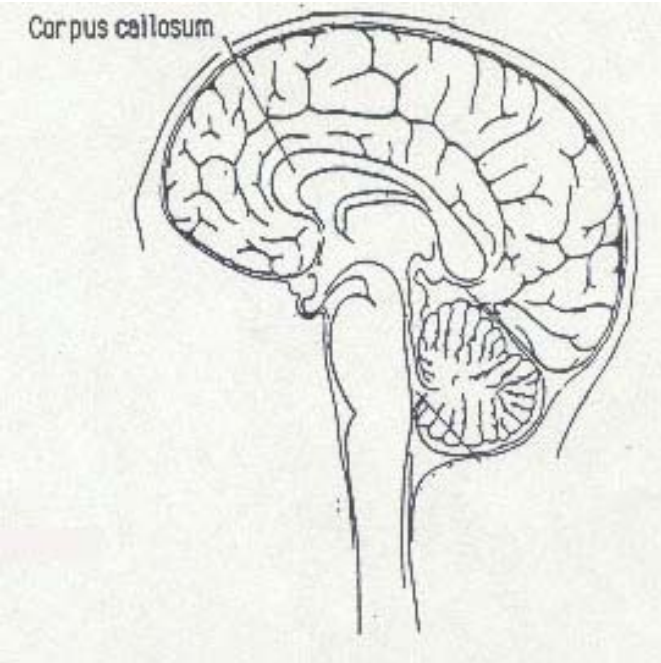
a) **Visual** reception and perception, and integrating eye movements to fix the eye on objects.

b) Clinical aspect - blindness (despite the eyes normal functioning).

6. **Corpus callosum**

a. Location - deep within the cerebrum.

b. Function - large bundle of myelinated commissural neurons that connect the left and right hemispheres.



7. **Basal Ganglia**:

   a. Location - deep within the cerebrum.

   b. Three large paired masses of gray matter (Caudate nucleus, Putamen & Globus pallidus)

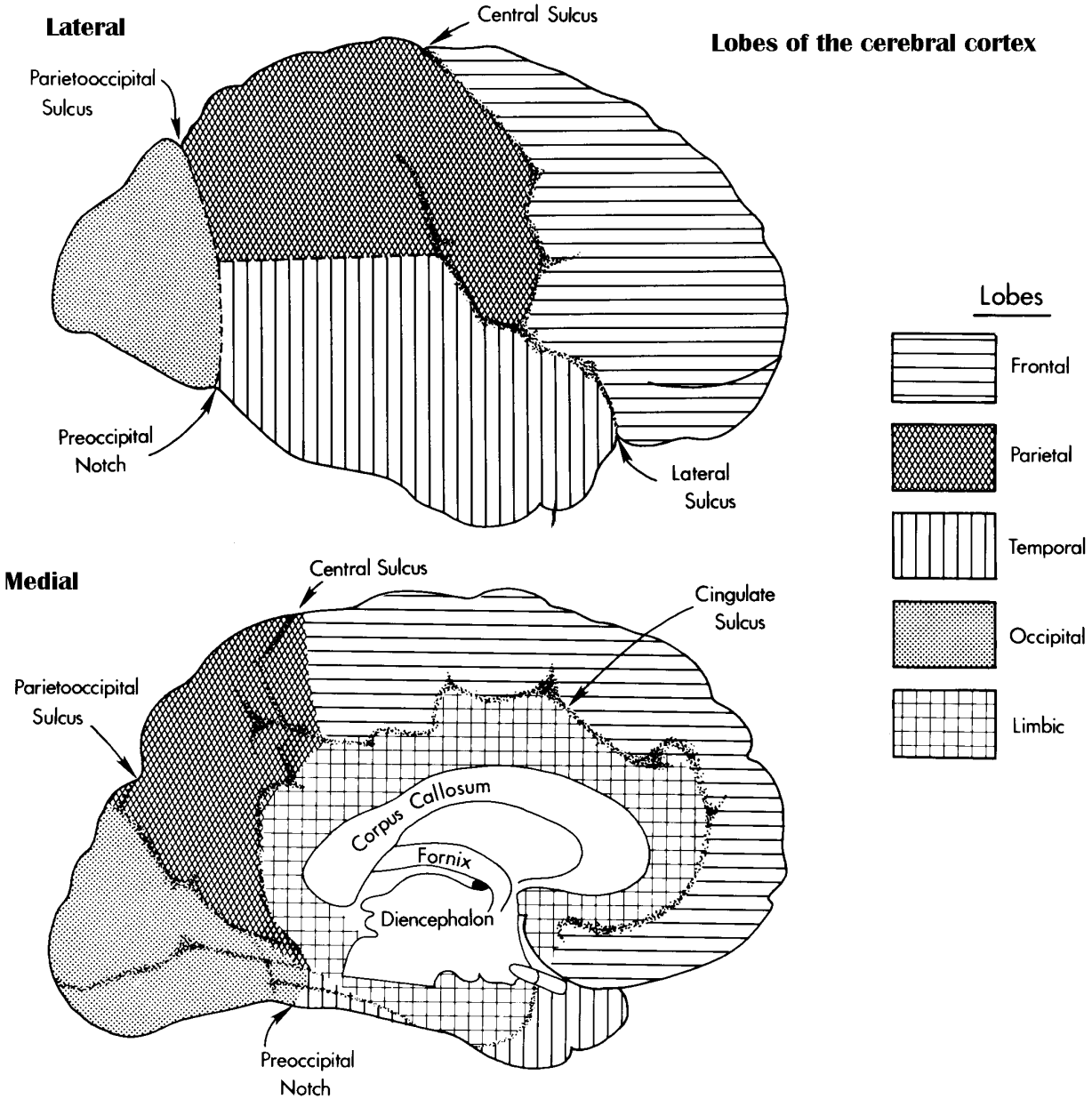
   c. Function: aid in initiation and control of somatic movements.

   d. Clinical aspect - **Parkinson's disease** and **Huntington disease** are two common disorders of the basal ganglia.

8. **Internal capsule**:

   a. Location - deep within the cerebrum, between the basal ganglia and the thalamus.

   b. Function - myelinated axons connecting the cerebrum with the rest of the brain.


Lateral
Central Sulcus
Parietooccipital Sulcus
Preoccipital Notch
Lateral Sulcus
Lobes of the cerebral cortex
Lobes
Frontal
Parietal
Temporal
Occipital
Limbic
Medial
Central Sulcus
Cingulate Sulcus
Parietooccipital Sulcus
Corpus Callosum
Fornix
Diencephalon
Preoccipital Notch

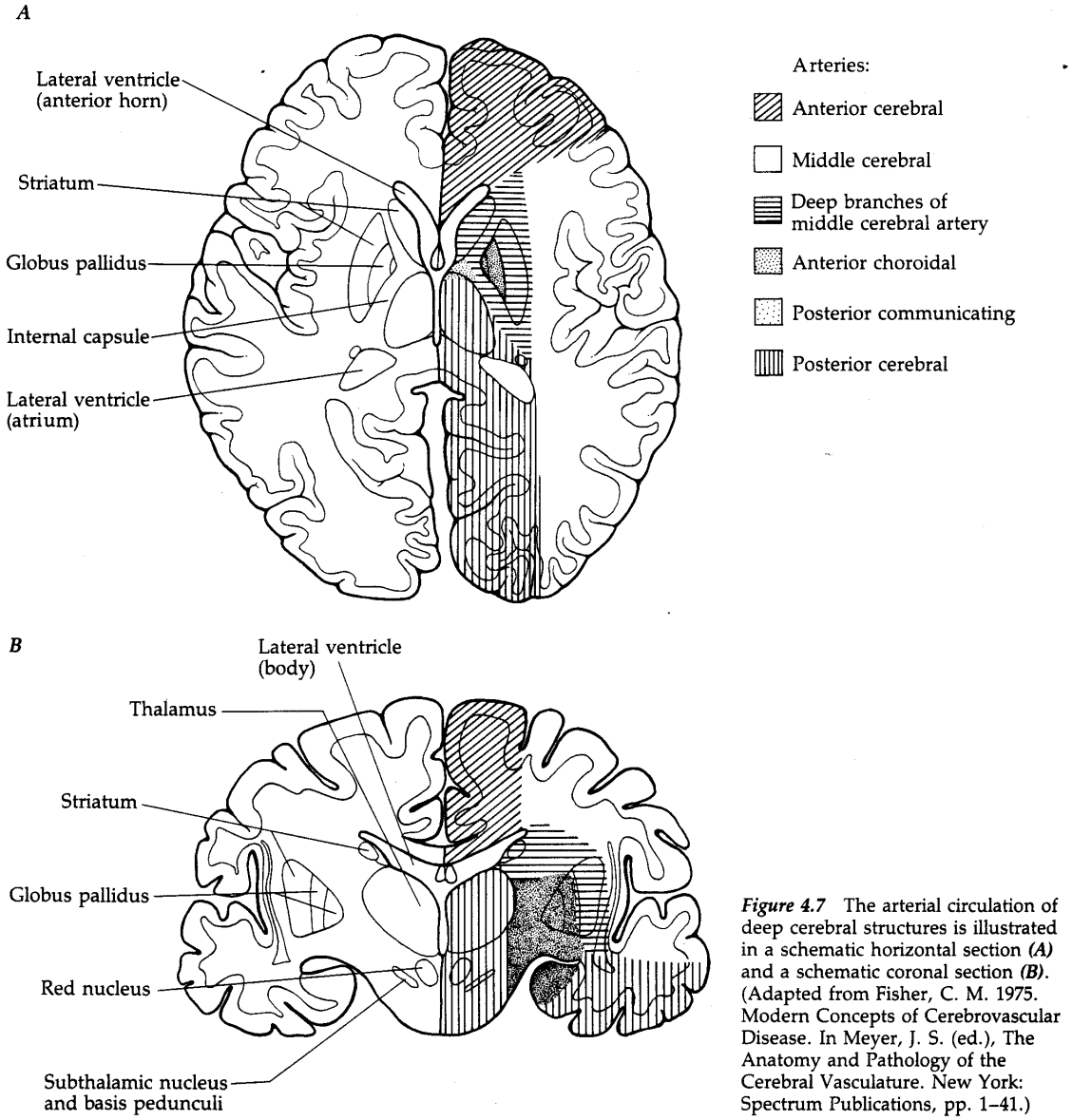


Figure 4.7 The arterial circulation of deep cerebral structures is illustrated in a schematic horizontal section ***(A)*** and a schematic coronal section ***(B)***. (Adapted from Fisher, C. M. 1975. Modern Concepts of Cerebrovascular Disease. In Meyer, J. S. (ed.), The Anatomy and Pathology of the Cerebral Vasculature. New York: Spectrum Publications, pp. 1–41.)

C. **Diencephalon**:

1. Contains the thalamus and the hypothalamus.

2. **Thalamus**:

   a. Location - medial to the internal capsule, directly inferior to the cerebrum. Paired structures shaped like eggs.

b. Functions:

1) Relay and integrative center for all **sensory** impulses on their way to the post-central gyrus of the parietal lobe of the cerebral cortex.

2) Where conscious recognition of pain and temperature, and the general awareness of pain and pressure occur.

3. **Hypothalamus**:

a. Location: inferior to the thalamus.

b. Function:

1) Controls & maintains a balance between the sympathetic and the parasympathetic nervous system.

2) Controls body temperature, sleep, hunger, blood pressure, sexual rhythms and emotions (anger/placidity).

3) Major integration center between the nervous system and the **endocrine** system. Synthesizes and secretes hormones which regulate the activities of the pituitary gland.

D. Brainstem:

1. Consists of three structures: midbrain, pons and medulla oblongata.

2. **Midbrain**:

a. Location: inferior to the hypothalamus.

b. Functions:

1) Relays impulses from the cerebral cortex to the brainstem and the brainstem to the thalamus.

2) Relays impulses between the cerebellum, basal ganglia, cerebrum and spinal cord to coordinate muscle movements.

3) Contains the nuclei of the cranial nerves III and IV (oculomotor & trochlear).

3. **Pons**:

a. Location: inferior to the midbrain, the anterior rounded portion of the brainstem that is anterior to the cerebellum.

b. Function:

1) Relays impulses from the medulla oblongata to the midbrain, the cerebrum to the cerebellum (motor impulses) and the left hemisphere of the cerebellum to the right hemisphere of the cerebellum.

2) Contains the nuclei for cranial nerves V, VI and VII (trigeminal, abducens & facial).

3) Aids the medulla oblongata in controlling respiration.

4. **Medulla oblongata**:

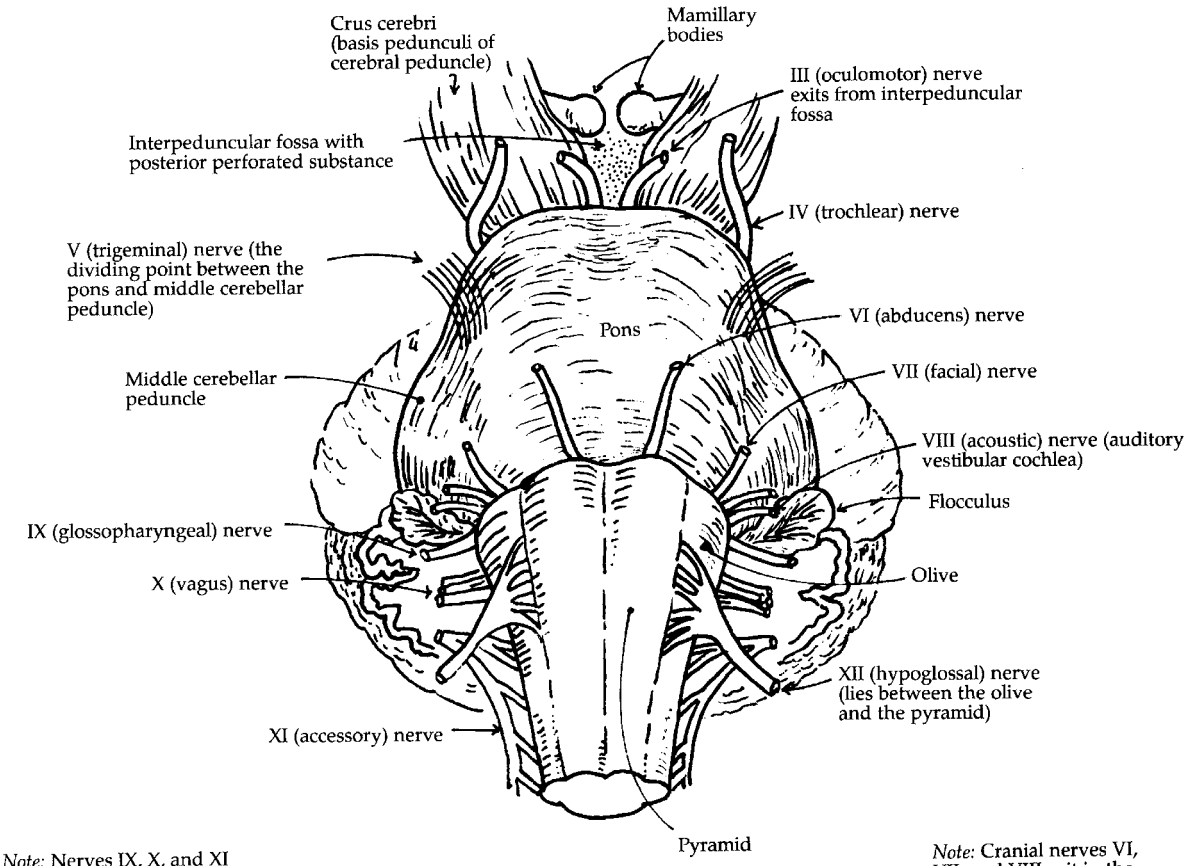
a. Location - inferior to the pons, superior to the spinal cord.

b. Functions:

1) Relays impulses between the spinal cord and the rest of the brain.

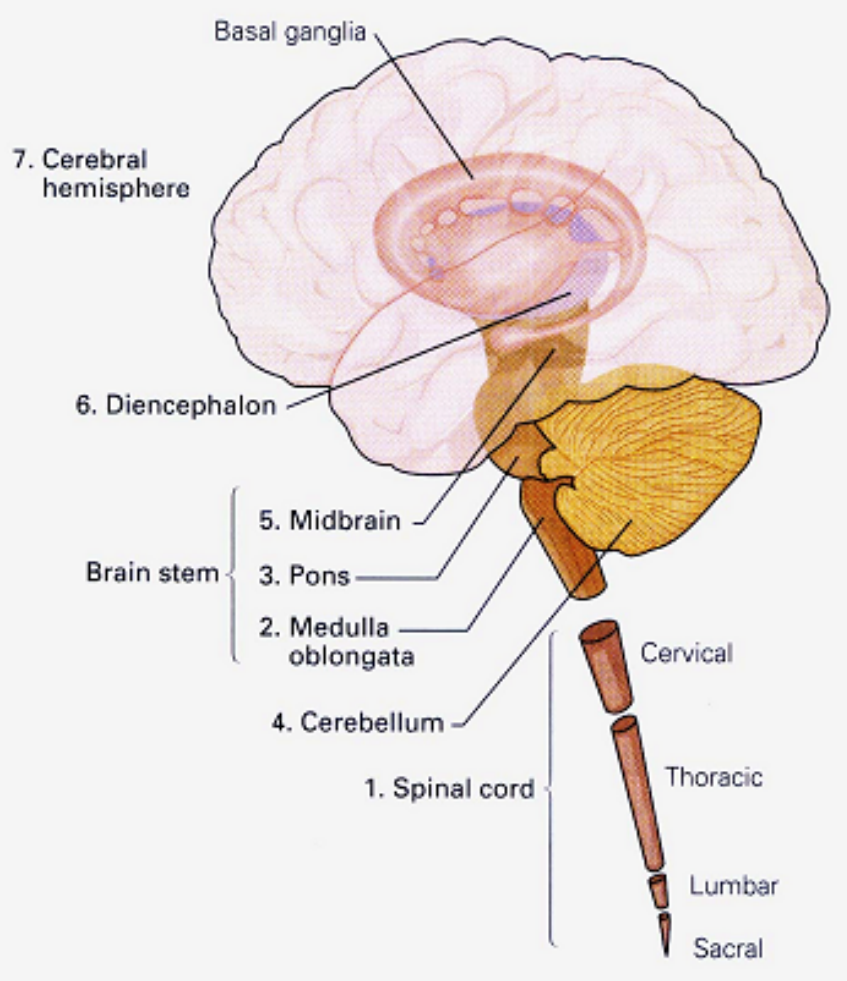
2) Regulates the heart rate, blood pressure, respiratory rate, swallowing, coughing, sneezing, vomiting, hiccuping & laughing.

3) Contains the nuclei of the cranial nerves VIII, IX, X, XI and XII. (acoustic, glossopharyngeal, vagus, spinal accessory and hypoglossal).



Note: Nerves IX, X, and XI lie in a perpendicular line along the long axis of the medulla.

Note: Cranial nerves VI, VII, and VIII exit in the groove between the pons and the medulla.



E. **Cerebellum**:

1. Location - posterior to the pons, inferior to the cerebrum.

2. Composed of two symmetrical lobes, with a cortex composed of gray matter and the internal regions composed of white matter.

3. Function - **subconscious** control center for coordination of somatic movements, equilibrium and muscle tone for posture.

4. Clinical aspects - lesions of the cerebellum result in loss of coordination (**asynergia**), inability to perform rapidly alternating movement (**adiadochokinesia**), **intentional tremor, hypotonia** or **hypertonia** and/or a rapid involuntary movement of the eyeball (**nystagmus**) on the **ipsilateral** side.

WORKSHEET
Central Nervous System: The Brain

OBJECTIVE A

State the names , function and location of the three meninges of the brain.

Meninge	Function	Location
1.		
2.		
3.		

OBJECTIVE B

State the four arteries that supply the brain.

1.
2.
3.
4.

State the four ventricles within the brain.

1.
2.
3.
4.

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OBJECTIVE C

Identify the labeled parts of the cerebral cortex diagram.

1.
2.
3.
4.
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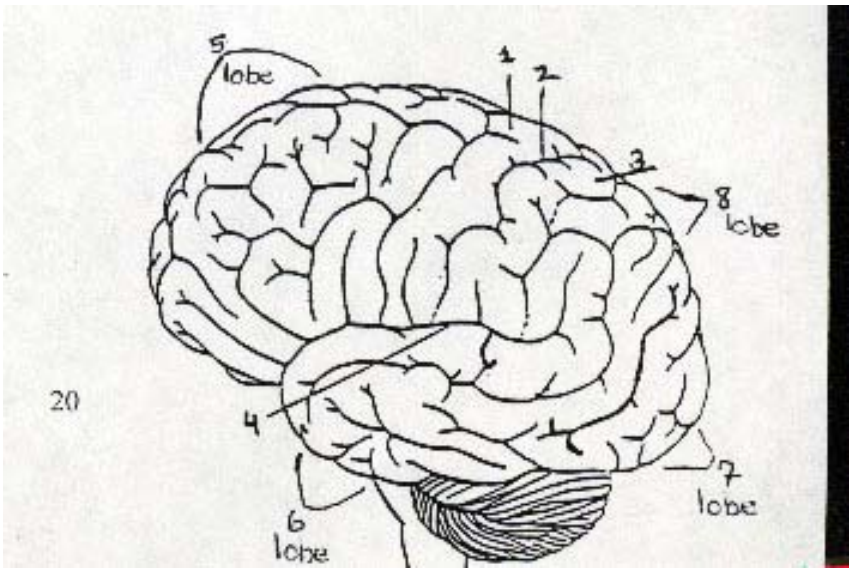
7.
8.



OBJECTIVE D

State the functions of the following:

1. Frontal lobe:
2. Parietal lobe:
3. Occipital lobe:`
4. Temporal lobe:
5. Corpus callosum:
6. Basal ganglia:
7. Internal capsule:

OBJECTIVE E

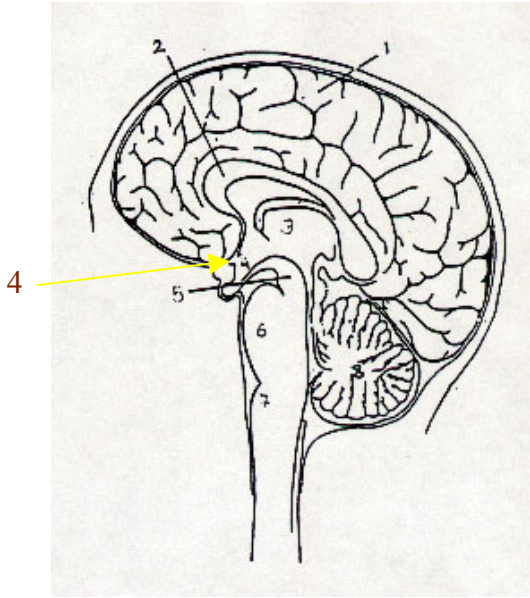
State the functions of the following:

1. Thalamus:
2. Hypothalamus:
3. Midbrain:
4. Pons:
5. Medulla Oblongata:
6. Cerebellum:

OBJECTIVE F

Label the indicated parts of the brain:

1.
2.
3.
4.
5.
6.
7.
8.



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OBJECTIVE G

State the part of the brain that is most responsible for the disorder listed below:

1. Meningitis
2. Hydrocephalus
3. Cerebrovascular accident
4. Upper motor neuron lesions
5. Expressive aphasia
6. Visual aphasia
7. Receptive aphasia
8. Parkinson's disease
9. Huntington's disease
10. Asynergia
11. Intentional tremor